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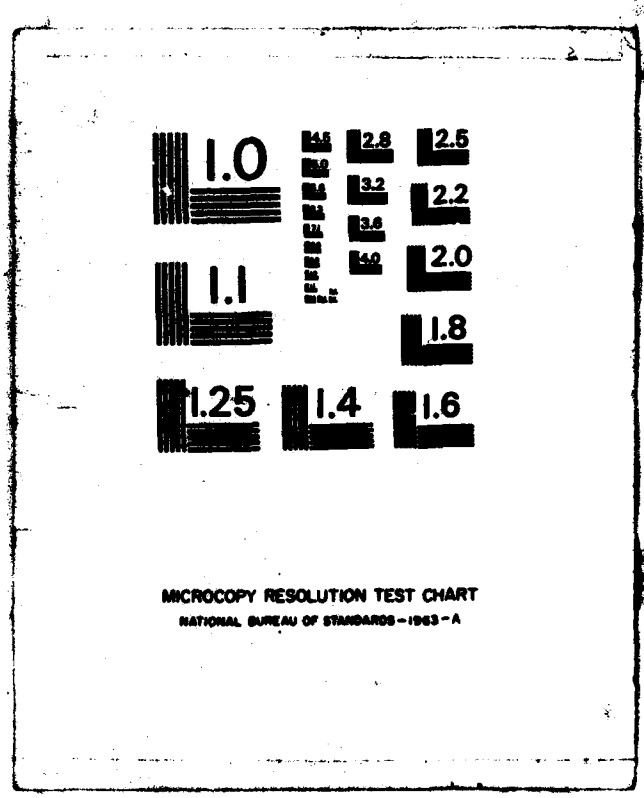
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FOREIGN TECHNOLOGY DIVISION

SEMI-AUTOMATIC CONTACTING SYSTEM "GR-1" IN MARINE RADIOS

by

Andrzej Gorski

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SEMI-AUTOMATIC CONTACTING SYSTEM "GR-1" IN MARINE RADIOS
(Adaptation of a Communication System for Changing Characteristics of the Radio Channel)

Andrzej Gorski

Intensive work on information systems in merchant and fishing fleets, which began in the seventies on an international scale, has necessitated a reorganization and modernization of marine radio communication systems. /233

Among the basic tasks which must be fulfilled by future information systems, we have:

- insurance of the safe traffic of the fleet (traffic);
- technical servicing of a ship (utilization);
- repairs of the fleet (renovation);
- mercantile exploitation (exploitation).

The cited demand the transmission of an enormous amount of information (preliminary, partial, principal) from ships to shipowners, data processing centers and in the reverse direction.

Presently, marine radio communication systems do not have the capability to transmit such an enormous amount of information and, above all, do not meet the requirements with regard to fidelity of information transmission and speed of transmission during appropriate time intervals.

As a result of scientific research and exploitational work conducted in many countries, a radio communication system has been worked out that answers data transmission from ship to land and

vice versa. According to "Regulamin Radiokommunikacyjing z zalecenia CCIR Nr 476" (Radio Communication Regulations recommended by "CCIR" Number 476) and many other publications and recommendations, the so-called marine data transmission system will be based for many more years on the presently introduced system of narrow-band radiotelegraphy with direct print-out. The provisionally initiated (1978-1979) system of remote printing telegraphy with detection and correction of errors, whose technical parameters couple with those given in Recommendation Number 476 CCIR, is based on existing conventional marine radio communication links.

The basic block diagram of the system is presented in Figures 1 and 2. The operating procedures of the system are defined by the "Regulaminu Radiokomunikacyjny" (Radio communication Regulation). The system of narrow-band radio telegraphy with direct print-out is automatic with regard to entry into and exit from the system. The assurance of the conditions for the correct automation of the system requires first of all a proper quality of the signals received from both directions, and this is where explitational problems arise. Under good mutual hearing conditions, the system works properly, but when the conditions deteriorate and difficulties arise in the assurance of good communication, the usefulness of the system becomes problematic.

In order to correct the operation of the system, to enhance its effectiveness, and to eliminate its basic flaw, many improvements were introduced in several countries, including Poland. The basic inconvenience of the system is the difficulty in the selection of an optimal frequency of operation in a given time interval. The improvement in the country consists in adapting a contacting system for changing channel characteristics. One of the possible means is the semi-automatic system conventionally called GR-1.

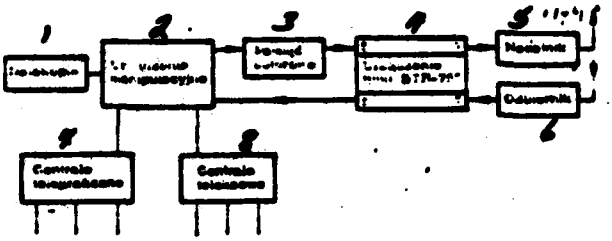

Figure 1. Coast station equipment (stage 1).

Key: 1--teleprinter; 2--manipulating arrangement; 3--buffer memory; 4--apparatus of the type STR-750; 5--transmitter; 6--receiver; 7--telegraph center; 8--telex center.

The introduction into the marine radio communication service of narrow-band remote-printing telegraphy for the purpose of data transmission from a ship to land and vice versa necessitates organizational-technical changes in the classical operating mode of the coastal station and of the station on deck.

The organizational-technical changes must bring about:

- an improvement in making contact;

- a reduction in exploitation costs;

- facilitation of the work of the station operators both on land and on ships;

- an increased reliability in data transmission from ship to land and vice versa;

- a correct utlization of the radio channels in the short wavelength and in the "UKF" (ultra-short-wave length) range;

- limitation of the unproductive operating time of the system's instrumentation;

- consideration of worldwide developmental trends in radio communications;

- full compliance with the recommendations of the CCIR.

The present method of initiating data transmission from ship to land and vice versa via coastal stations which consists in equipping the stations with data transmission apparatus of type STB-75 and operating therewith in the classical contact mode, does not fulfill the basic requirements. The present method of initiating data transmission must be treated as provisional, as it does not permit the selection of the optimum operating frequency, and thereby increases the amount of unproductive operating time of the equipment. This hence causes both an increase of busy periods and also quite an overloaded short wavelengths range.

By the term "classical contact mode" the authors mean: contacting by the method of successive probing at the allotted operating frequencies in various bands, operation at high power, an increase in radiated power in case of difficult communication, etc. In connection with the foregoing, the authors of the project GR-1 — a semiautomatic contacting system — submitted for consideration an original solution to the problem of data transmission between ship and land which has not been envisaged in the country thus far.

The semi-automatic contacting system GR-1 is based on an analysis of worldwide trends in this field, while also taking into utmost consideration the country's exploitational achievements thus far. The basic technical assumptions of the system GR-1 can be presented as follows:

- a new contacting system is introduced which is based in the preliminary phase on equipment from foreign firms adapted for the purpose of the system GR-1 and in a subsequent phase on the country's equipment;

- after making contact, data transmission will be performed by means of data transmission apparatus that is available to stations on shore and on deck, whose specifications agree with the recommendations of Number 476 CCIR.

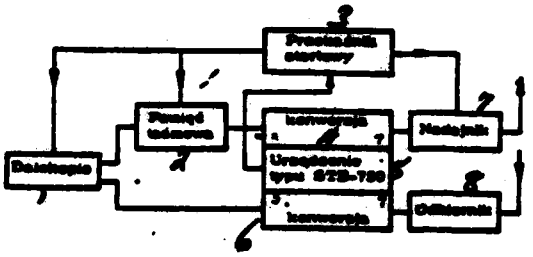

Figure 2. Equipment of the station on a ship (stage 1).

Key: 1--teletype; 2--tape memory; 3--starting relay; 4--converter; 5--apparatus of the type STB-750; 6--converter; 7--transmitter; 8--receiver.

The new contacting method will be based on an automatic evaluation of the quality of the radio channel, and will thereby allow operation at optimum operating frequencies.

Among the main advantages of the proposed system we include:

- the fulfillment of the basic requirements;

- the possibility of introducing in the future the fully automatic data transmission system GR-2 without changing the essential framework of the system GR-1. Only those links of the system GR-1 will be subject to automation that now require servicing by an operator. The system GR-2 will be based on the utilization of "EMC" at the coastal station. At the same time, it should be observed that one cannot consider the introduction of GR-2 without the prior installation of GR-1.

- a significant improvement of the conditions of radio communications in the mobile marine service in the radio-telephone and radiotelegraph system.

An illustrative block diagram of coastal station equipment operating according to the system GR-1 is presented in Figure 4.

The number of installations is given by way of example; this number can be built up at will. The first contacting stage is the selection of the optimum operating frequency of the transmitting coastal station and of a paired receiving frequency.

The process of selecting the optimum frequency is fully automatic and proceeds as follows:

- the coastal station sends uniform sounding signals from all active transmitting installations that are assigned to teleprinting work, as well as to telephone work and to manual telegraphy;

- in the mechanism of the "scanning system" of the stations on shore and on deck, all the operating frequencies assigned to the coastal station are coded. The scanning process occurs synchronously at both stations;

- the level of the sounding signals is automatically evaluated by a receiver which scans the frequencies at the station on deck; the signal to noise ratio is evaluated concurrently;

- simultaneously, at the coastal station, the noise level at the receiving frequencies of the coastal station is evaluated (which together with those transmitted to the ship constitute a pair of frequencies);

- the information on the noise level at the receiving frequencies of the coastal station is coded at the installation and is sent to the station on deck together with the sounding signals (Figure 5);

- simultaneously, with the sounding signals and with the information on the noise level,signals are transmitted to the station on deck which synchronize the frequency-scanning process and the data-conversion process;

- the selection process is completed with a display at the signalling installations of the result, i.e., of the optimum frequency.

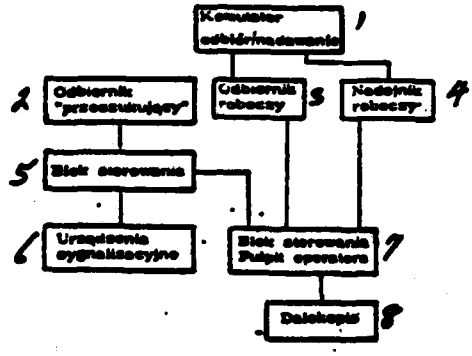

Figure 3. Block diagram of the station on deck in the system GR-1.

Key: 1--reception/transmission commutator; 2--scanning receiver; 3--operating receiver; 4--operating transmitter; 5--steering block; 6--signalling installation; 7--sterring block; operator's console; 8--teleprinter.

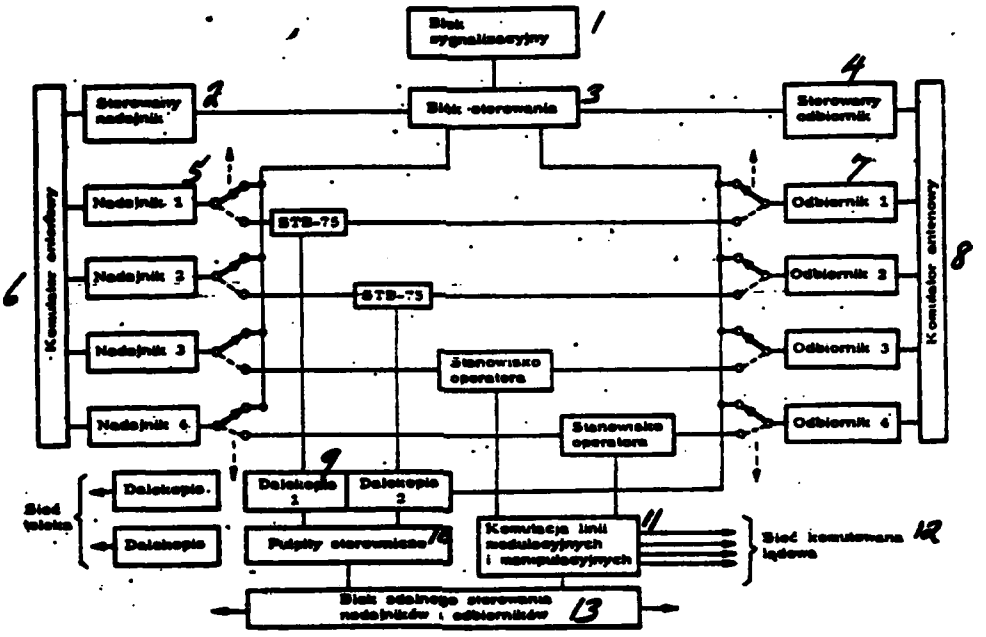

Figure 4. Block diagram of the coastal station in the system GR-1.

Key: 1--signalling block; 2--controlled transmitter; 3--controlled block; 4--controlled receiver; 5--transmitter 1,2,3,4; 6--antenna commutator; 7--receiver 1,2,3,4; 8--atenna commutator; 9--teleprinter; 10--control console; 11--commutation of modulating and manipulating lines; 12--commutated land net; 13--block for remote steering of transmitters and receivers.

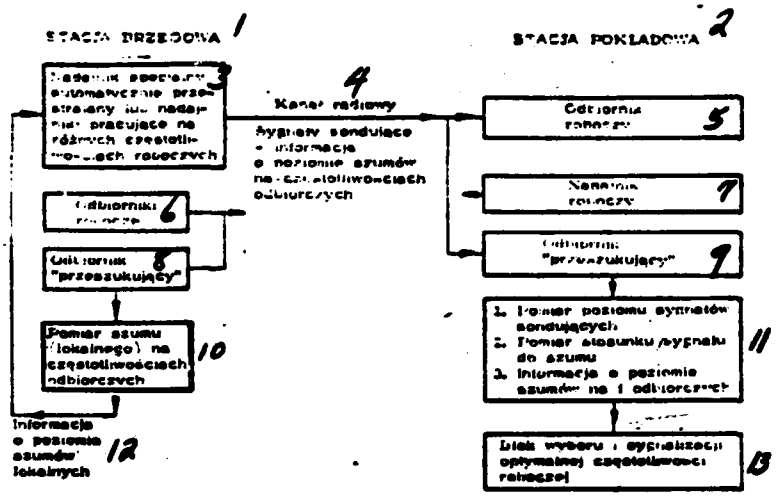

Figure 5. Illustration of the principle of selecting the optimum operating frequency.

Key: 1--coastal station; 2--station on deck; 3--special autmoatically tuned transmitter or transmitters operating at different operating frequencies; 4--radio channel sounding signals plus information noise level at the receiving frequencies; 5--operating receiver; 6--operating receivers; 7--operating transmitter; 8--scanning receiver; 9--scanning receiver; 10--measurement of the (local) noise at the receiving frequencies; 11--1. measure of the level of the sounding signals, 2. measure of the signal to noise ratio, 3. information on the noise level of the receiving frequencies; 12--information on the local noise level; 13--block for selecting and signalling the optimum operating frequency.

In case the coastal station is not operating at a given time at one of its operating frequencies, this frequency is treated in the selection process as though there were no communications.

The entire cycle of sounding and selection for e.g., 20 operating frequencies lasts a few seconds, and is repeated e.g.

every 30 minutes, so that it does not cause any disturbance to normal operations.

The selection process is automatic and occurs without servicing by operators of the station on the coast or on deck. The ship's operator thus receives valuable information (on the optimum operating frequency) displayed in the signalling block of the installation.

By observing the display, he can even draw conclusions as to propagating conditions and stormy communications. In case of deterioration in the quality of the radio channel during a program, the system for selecting the optimum operating frequency will indicate a second frequency to which the operation should be switched. The operator of the station on deck tunes the transmitter to the indicated operating frequency and resumes operation by sending a signal for a selective call in the system UTD of the type STB-75. Since the coastal station is also sending sounding signals at radio-telephonic frequencies, the ship's operator will also obtain the optimum working frequency for this kind of transmission.

The activation of the transmitter of the station on deck at the selected working frequency is achieved with the aid of personnel, who perform the tuning and the matching of the transmitter to the antenna.

When required to transmit news to the ship, the coastal station supplies information on the kind of news, and, upon reporting from the ship,transmits the news at the optimum frequency designated by the ship.

The following example is a good illustration of the increase in the effectiveness of the utilization of radio channels in the short wavelengths range by applying the system GR-1 to forecast the optimum working frequency:

- average duration of a radiotelephone conversation 10 min.

- average time for preparing a conversation via radio (calling, contacting attempts in various bands in the short wavelength range) 8 min.

- unproductive time in which the channel is really occupied per thousand average conversations 133.3 hours

- time occupied productively 10 min. X 1000 166.6 hours

Conclusion: Considering the increase in effectiveness of the system GR-1 of the order of 14, with the system GR-1, one obtains unproductive period of 9.5 hours, as compared with the unproductive period [of] 133 hours with the classical system of radio communication.

- mean duration of a (telephone) conversation from ship to land 10 min.

- average time of preparing for the conversation vai radio (scanning for the frequency of the coastal station, contacting attempts and turning of the transmitter, etc.) 20 min.

- unproductive time really occupied per 100 conversations, 100 x 20 33.3 hours

- time productively occupied 16.6 hours

Conclusion: Accepting the increase in effectiveness of the system GR-1 of the order of 14, results in

- unproductive time with system GR-1 2.3 hours

- savings in unproductive time 33.3 - 2.3=31 hours

The coefficient of the increase in effectiveness, W=14 (e.g. the example), was determined on the basis of experiments by foreign firms and also of our own laboratory experiments. For instance, fo. the system CURTS (Common User Radio Transmission Sounding) this coefficient was determined to be W=20, for the system CHEC. W=18 is accepted on the basis of exploitational studies. The definition of the coefficient of effectiveness of a contacting system differs in many publications. The following was accepted for the system GR-1:

$$W = \frac{\text{Unproductive operating time of radio link in the classical system}}{\text{Unproductive operating time of radio link in system GR-1}}$$

Table 1. Illustrative Basic Equipment of a Station on Deck

Name & Type of Instrum.	Basic Specifications	Present System	System GR-1
1. Radio communication transmitter, e.g. MEWA-2	1000W PEP 4÷25 MHZ tunable and manually adjustable	+	+
2 Main radio telecommunication receiver; e.g. EKD-02 Rediform, Marconi	sensitivity A3=2nV A1-0.5nV manually tuned	+	+
3. Radio communication receiver (reserve)	as above	+	-
4. Scanning radio communication receiver for the system GR-1 type CR302A (Racal 7916)	as above automatically tuned	-	+
5. Instrumentation of the type STB-75 (remote-writing narrow-band telegraphy)		+	+
6. Block for steering the measurements and mechanisms of the system GR-1 (e.g. Canadian producer, Hermes Division, system CHEC)		-	+

Key to Table 1: + is required; - is not required.
Note: CHEC - Channel Evaluation and Call System.

The coefficient of effectiveness for the system GR-1 permits a numerical determination of the time available i.e., the time remaining available to the station to perform additional service tasks, to speed up communications between the ship and land, etc.

Figure 4 gives the block diagram of the coastal station, calls for a further explanation. Figure 4 shows two technical solutions for sounding:

- the first one, based on a single transmitter with a wide-band power amplifier dedicated to sounding purposes, automatically tuned to the programmed frequencies in synchronism with the scannig receiver;

- the second one, based on the emission of sounding signals by all operating (work) transmitters in conjunction with a switching method.

The introduction of the semi-automatic contacting system GR-1 requires instrumentation which can be defined by comparing the present equipment of a station on deck with the equipment required by the system GR-1.

As seen from the items listed in Table 1. and Figure 3, the equipment of a station on deck for the system GR-1 as compared with the present classical equipment differs only in two points:

- a necessary automatically tuned receiver in lieu of a manually tuned receiver of the same class;

- a required steering block in the system GR-1.

The remaining equipment in both the classical and the GR-1 systems is identical. The coastal station should have similar equipment.